Hesperian Age for Western Medusae Fossae Formation, Mars

James R. Zimbelman* and Stephen P. Scheidt

The Medusae Fossae Formation (MFF) on Mars is an intensely eroded deposit near the northern edge of the cratered highlands, between ~130° and ~230°E longitude and ~15°S to ~15°N latitude (*1*–*3*). Recent geologic mapping of western and central MFF (*4*) identified outliers of MFF materials well beyond the previously mapped limits of the deposit (*5*), including outliers close to Gale crater, the landing site chosen for the Mars Science Laboratory (MSL) rover Curiosity, en route to an August 2012 landing.

Global mapping identified three members of MFF (upper, middle, and lower); Viking-based crater counts showed all members to be Amazonian in age (*1*, *2*), younger than the Hesperian and Noachian systems (*6*). Divisions between the three martian eras likely correspond to ~3.5 and ~3.8 billion years (Ga), although this is dependent on production functions used (*7*). We present crater size frequency distributions and inferred ages derived from craters counted on recent spacecraft imaging data for four mapped MFF subunits (*4*, *5*) (Fig. 1 and fig. S1). We subdivided the lower member of MFF into two units on the basis of superposition; the stratigraphically upper component has an early Amazonian age (Aml2), whereas the lower component has an age near the Amazonian-Hesperian boundary (AHml1). Craters on a nearby exposure of middle-member material (superposed on the lower member) indicate a late Hesperian age (Hmm). An exposure of lower-member materials in the central portion of MFF [Hml, MC-16 NW (*4*, *5*)] has a crater size frequency distribution statistically indistinguishable from those of the AHml1 and Hmm units. These results indicate that the crater retention ages for MFF units likely represent surface exposure ages rather than emplacement ages; the lower-member units experienced substantial erosion into the early Amazonian, even though late-Hesperian-aged middle-member material (showing less evidence of resurfacing) is superposed on some lower-member exposures. Therefore, emplacement of both the lower and middle members occurred before the late Hesperian, much earlier than indicated by prior investigations (*1*, *2*, *8*) but consistent with recent work that suggests a Hesperian age for portions of MFF (*9*).

A Hesperian age for western MFF has implications for materials at the MSL landing site. Aml2 materials consist of uniformly bedded materials quite similar to layers near the top of the Gale mound (fig. S2); both terrains are unlike the variable-thickness layers exposed in the lower portions of the mound (*10*). Our MFF results are consistent with recent cratering results for the entire Gale mound, which indicate a late Hesperian to early Amazonian exposure age (*11*). There may not be as substantial a time gap between the upper and lower portions of the Gale mound, despite the presence of an unconformity between the mound units (*10*). The hypothesized ignimbrite origin for MFF (*12*–*14*) may thus apply to the regularly layered upper units of the Gale mound. Curiosity may test this interpretation while exploring the Gale mound.

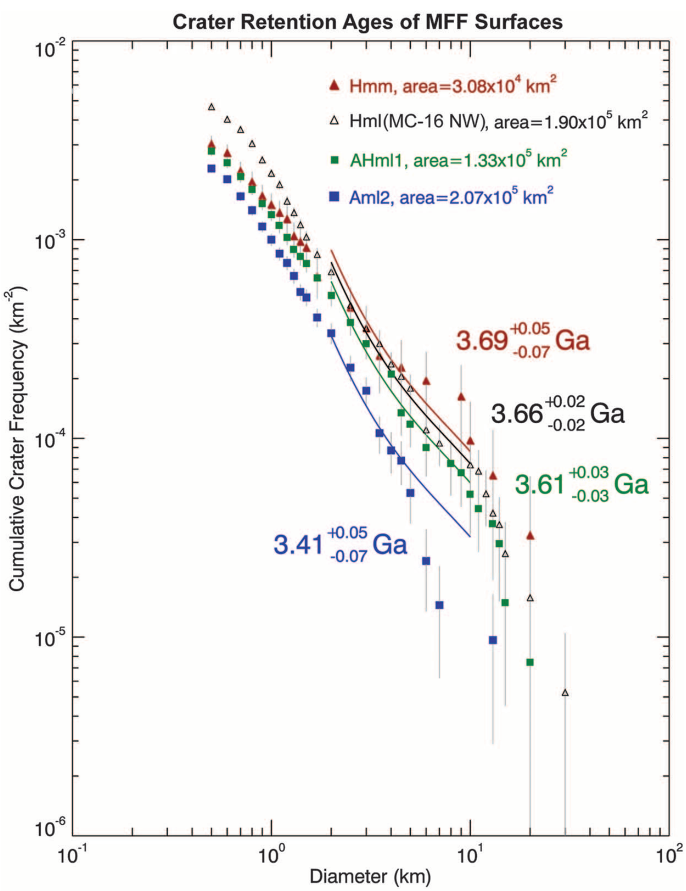

Fig. 1. Binned cumulative crater frequency data for three MFF units in quadrangle MC-23 NW and unit Hml from quadrangle MC-16 NW (black symbols). Crater retention ages (with 1σ error estimates) were derived from fitting craters in the 2- to 10-km-diameter range (*4*).

References and Notes

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Supplementary Materials
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Materials and Methods
Supplementary Text
Figs. S1 and S2
Table S1
References (*15*–*18*)

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Center for Earth and Planetary Studies, MRC 315, National Air and Space Museum, Smithsonian Institution, Washington, DC 20013–7012, USA.

*To whom correspondence should be addressed. E-mail: zimbelmanj@si.edu